



VOLUME 6 2013

The International Journal of

Design Management and Professional Practice

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Opinions

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Abstract: This paper considers the perceptions of design consultancies and in house design teams about design for environment (DfE) and its implementation. The research reported investigates the current design for the environment practices, if any, that are evident within twenty British product development teams. Semi-structured interviews were undertaken where possible with designers, engineers, production managers and managing directors about their current projects in order to generate a state of the art picture about the adoption of DfE in product development. The paper presents an overview of the preliminary analysis of these case studies and proceeds to highlight the difficulties that design for the environment faces within product development teams; these include low reputation, recognition and adoption of DfE, as well as a lack of cohesive direction across the process. The need for further research that focuses on how these difficulties could be overcome in different parts of product development and the wider context of operations management is highlighted.

Keywords: Design for Environment, Eco-tools, Product Development, Design Team, Case Study, Sustainability

THE DEVELOPMENT OF DESIGN FOR ENVIRONMENT FROM ACADEMIA TO INDUSTRY

Design for Environment (DfE) is mainly concerned with designing out or reducing the environmental impacts of products or services-carbon footprint, recyclability, weight reduction, etc; (House of Lords, Science and Technology Committee 2008). The process under its various headings (eco-design, green design, sustainable design, etc...) has evolved as a discipline over the last two decades (Baumann et al., 2002; Boks 2008). Baumann et al., in their 2002 review of the green product development literature explain that research in the area has focused on eco-tools: “*finding ways of describing environmental aspects of material selection and generalised ways of dealing with environmental information*” (p.415). Other research concentrates on case studies illustrating the potential of DfE applications for industry and of DfE tools developed by academics.

Baumann et al., add that research presents “*a fragmented approach to the issue*”, lacks a business focus and conclude that: “*few references deal with the integration of management issues, environmental issues and product development activities.*” (2002, p.415). Although the need for DfE to refocus on organisational issues, capabilities, communication and structure is not new (Bras 1997), Karlsson and Luttrupp (2006) argue that many researchers have been more

interested in introducing new tools than evaluating or adapting existing ones. Boks and McAloone (2009) broadly agree but add that research since the review by Baumann et al., (2002) has started to focus more on organisational issues and to move away from the creation of eco-tools.

In industry there remains a more limited appreciation of DfE (Tukker et al., 2001; Boks & McAloone 2009) and generating an understanding of the problems associated with DfE and its implementation in British product development teams is an under-researched area. The DfE scene has however evolved considerably over the last decade and an appreciation of the current state of the art of British product development teams, with regards to DfE practices and perceptions of the drivers and barriers to the process, can support recommendations about how to move it forward.

Developing a Better Understanding of DfE Perceptions and Practices

The research undertaken and presented in this paper has explored the perceptions of British product development teams about the concept and implementation of DfE. It has also investigated the current DfE practices that are evident within these teams without any particular emphasis being paid to success stories.

Methodology

This research adopted a multiple case study approach in twenty ‘in house’ teams and design consultancies. The study encompasses small, medium and large enterprises, the sample covering over 80% of the British product design consultancies in terms of market share (Relph-Knight 2011, p.39). 65 semi-structured interviews were undertaken with 55 interviewees fulfilling various roles in the organisation (designers, engineers, production managers, managing directors, etc). Interviewees were asked about their current and recent DfE projects, being defined by a DfE intent, where environmental criteria are part of the brief.

Table 1: Cases and Interviews Spread

	Design Consultancies	In-House Design Teams	Total
Number of Interviews	18	47	65
Number of Cases	7	13	20

This multiple case study design enabled the gathering of a greater variety of findings. Moreover, the use of a larger sample size and of comparative cases from different settings enabled this research to corroborate patterns of association and therefore to offer potential for contextualised generalisation and theory building. Multiple case studies also support a high generation of findings without drawing upon too much resource from each case participant in an industry where time is very precious.

The interviews provided a rich and personalised picture of distinctive cases. Each participant offered an account with their own perspective informed by their different backgrounds and positions in the company. Respondents were guided by the researcher through the introduction of broad topics which allowed more freedom to express their views (Bryman 2008). The topics included ‘design process’, ‘DfE views and approach’, ‘communication’, ‘collaboration’, etc... These views were then compared, looking at company, sector or job type as variables.

This descriptive research is ongoing with current projects being tracked by the lead researcher. The purpose of this paper is to provide researchers and practitioners with the insights of the current stage of the analysis and to generate a dialogue on the issues raised. Further collection of data and analysis is underway, which will complete this work along with the feedback from both industry and the academic world.

Comparative Analysis

While the research is ongoing, the data collected underwent an initial stage of comparative analysis; this is presented below. The preliminary findings focus on issues affecting the adoption and implementation of DfE across the twenty research cases. Also, to illustrate these findings, each section presents quotes from interviews conducted across two cases and seven participants. The first case is a design consultancy where three participants were interviewed (DC1, DC2 and DC3). The second case is an SME designing and manufacturing in house where four participants were interviewed (IH1, IH2, IH3 and IH4). All participants work within the product development team.

Eco-tools and Methods of DfE Implementation

Interviewees were asked about the methods and tools for DfE implementation that they and their company used. As mentioned earlier, the use of eco-tools by industry has been identified as quite limited (Tukker et al., 2001; Boks & McAlloone 2009), and concurrently the research identified that there was a total absence of eco-design tools across all cases. Moreover, there were no projects driven by DfE principles and only a few where the implementation of DfE principles was considered.

Interviewer: Do you have any examples where you worked with clients to make a product more sustainable?

DC1: We have, but to be honest, we don't particularly get that kind of project.

The cases that consciously looked at DfE were primarily driven by the potential for cost benefit. Interviewees however stated, that although based on cost, some of their brief's criteria did relate to DfE and were considered in that respect; typically saving on material, minimising packaging or the housing of components, reducing weight, increasing recyclability, etc. Consequently, interviews focused on gathering data from those projects that had the intention in some form to lower environmental impacts.

In only one case had a design consultancy (the same one quoted here) developed a spreadsheet linking environmental impact data to a bill of materials. Within this company, one person was fully aware of, and able to use the tool.

DC2: We have created our own excel spreadsheet, that's based on the eco-indicator 99 model. [...] I am the only one that could use it. I had aspirations to make it available company wide, but we've had no time for that yet.

In other cases, designers would follow principles of DfE without any methods for measuring environmental impact or at best use rules of thumb and peer advice.

About the use of Eco-tools:

IH3: It was on the agenda, but it didn't happen, it didn't fit with what we do. It was more creating a marketing tool than a tool to move towards sustainability. I don't think we have enough operations to warrant the use of it. A lot of it is common sense and also making everybody aware of what they could, should be doing.

Efficiency, DfE and 'Good Design'

Across the different cases, interviewees were asked about their views on DfE as a discipline. There was a concurring opinion that in most cases, the practice of DfE and the use of principles

and methods for DfE were largely similar in terms of ‘good design’ practice and methods. This term, shared by the interviewees, defined the best practice in design and what design should be.

DC2: We don’t actively do Eco Design, but try and do what I would classify as good design, and part of that has naturally an element of it.

DC2: Sustainable design is just good design, it’s part of it. We don’t have to wait for a client to ask, we should be doing it anyway.

DC3: There’s this set of good design principles that ultimately make things environmentally better but it wasn’t necessarily the driver for doing that.

As mentioned above, the majority of interviewees stated that DfE principles were taken on only if it made financial sense. In most cases, DfE is limited to efficiency where the product development team aims to reduce material use, energy consumption or packaging for economic motive. The environmental benefit is sometimes only a lucky by-product or in some cases a potential marketing tool.

DC1: On the FMCG [fast-moving consumer goods] side, they want to use as little material as possible anyway and most of them are recyclable. And for their own profitability, they tend to be very efficient on transport and manufacturing, etc. I’m not saying they’re environmentally friendly companies, but being efficient is their business.

About DfE and efficiency:

DC1: From a design point of view, you always try to use as little plastic as possible, because you’re often designing down to a cost. And if we have a European material that’s more environmentally friendly, you can bet your life the client is not going to go for that and is going to choose a cheap one that’s probably been made in a very bad way.

DC3: It’s possibly a marketing focus to differentiate themselves. I’ve seen that before. I don’t know many do it for the environment and how many just want to do it just because it makes financial sense. I think they would phrase that as efficiency now. I just think it’s moving away from just being green, to being efficient, I think that word efficient is what is taking over. Resource efficiency is about good design, about good engineering, that’s why they come to consultancies, for those services. I don’t think they even know in their own head that they’re trying to be sustainable, but they want to be the most efficient.

In some of the cases, interviewees explained that the opposite is also true. Inefficiencies in the product development process can make a product worse from a DfE point of view. In house design teams expressed this view the most, stating that short timelines for example, had negative repercussions on the environmental aspects of their projects.

About DfE barriers:

IH4: we’re lacking the time to develop or integrate the sustainable solutions we want to do. [...] Going fast make it less sustainable when you have to reach tight deadlines.

'Green Champions' and doing the 'Right Thing'

Participants most interested in DfE explained that they spend some of their time looking at the DfE field and that while the gathering of information is regarded as commendable by senior management, the learning is in most cases self-driven.

They also explained that they only transfer small amounts of knowledge to their team; in some cases, they or their teams do not feel the need to gather knowledge, let alone transfer it. In addition, when DfE aware employees leave their company, their knowledge goes with them since there are in most cases no systems in place to capture knowledge and transfer it to the product development team or company. This problem of knowledge retention was experienced by the majority of cases.

DC2: I'm sort of, the unofficial sustainability champion here.

DC3: It's my passion, environmental stuff; therefore I do it in everything I do in life.

Some participants also express a wish for more DfE criteria and that DfE is the 'right thing' to do. They empathise with environmental problems and in some cases even criticise the fact that their work is contributing to those problems.

DC1: I've been to China, I've seen the way they make things, to be honest with you, it fills me with horror. But, I'm hoping there is more legislation coming over there, in terms of recycling and all that sort of thing.

DC3: I think it's scary, I think it's shocking people aren't coming here asking about it. I assumed there would be loads saying they want to be green and asking us about how to be green.

In one of the cases (an SME designing and manufacturing in house), the Managing Director explains that he took on the role of 'green champion' and is seen across his company to be driving the green agenda. However, regardless of his position in the company, he still experiences the problems of implementation described below.

Out of Our Control, not Part of My Responsibility

The majority of the interviewees felt that DfE implementation was out of their control. They explained that they are restricted by working for a client or market that does not ask for DfE to be addressed.

DC1: Ultimately, it's down to the client, we can suggest things, but sustainability is really something they have to ask for, because obviously we are a consultancy and we have to get paid for the hours we do.

It is interesting to note that while there was a distinctive group of interviewees motivated by DfE; another group felt that 'pushing' or investigating into it was not part of their responsibility. Employees' time is not accounted for in expanding DfE knowledge in any of the cases and this second group explained that they do not have the time, or bear the responsibility to gather knowledge on DfE.

IH1: I feel there are two types of designers; there are the ones that feel passionately about the environment and there are the ones that feel passionate about not being environmental in a way. From his perspective, why bother using bamboo if it's the same as vinyl. From my perspective it's the same but better for the environment so: yay!

Interviewer: Any DfE changes made to the product?

IH2: Not 100% sure. Could be.

Interviewer: I know of an example where you used bamboo?

IH2: Was that for a panel or something? Could have been.

[...]

About alternative materials:

IH2: Not in relation to sustainability. The materials we've got are pretty set. It's down to what we have in the workshop. It's not my part to deal with that.

Senior level staff also thought that DfE was not asked for enough by clients to be worth investing in. Few knew what they would do next if they had to develop this part of their offer and would have to look into it further if the need arose.

Lack of Time and Trust in Implementing Environmental Alternatives

According to the majority of interviewees, DfE is seen as a discipline with conflicting opinions. There is confusion as to why different environmental alternatives and strategies seem sometimes to contradict each other. There is also a general lack in confidence and sometimes, even trust with DfE, in particular regarding products' environmental claims and DfE implementation methods such as eco-tools and software. In some cases, there is a belief or concern that DfE alternatives will hinder the products' functions, properties or another part of the design.

IH3 explained that they use virgin aluminium and have looked at using 100% recycled aluminium but they want to spend more time looking at it. They fear the material may fail while in use although the supplier guarantees that it has the same properties. They are however constrained by time and cannot afford to look into it at the moment.

IH3: It's not really a case of I don't care, I do care, it's just a case that there are other things that need to happen so it's quite difficult to put it in.

Communication and Knowledge: Information not Driven Down

The research highlighted a clear lack of cohesion between design briefs' environmental objectives and the overall environmental objectives of a company. The interviewees directly involved in product development were usually not aware of the environmental objectives set by the companies selling the products nor do these generally appear in the briefs. If design briefs include environmental objectives, these are again usually set without any knowledge of the environmental management teams. In effect, it seems companies' overall environmental strategies are not driven down to product briefs and design teams.

It is interesting to note that the only case using an eco-tool (the design consultancy quoted here) was also the one appearing to use the most communication or collaboration tools. This company uses forums on their internal computer network to share information and interests, ask questions to peers and diffuse knowledge. However, even in this lone case where systems are in place for communication and knowledge transfer, the actual use of DfE is low. Interviewees talked about communication and collaboration examples relating to industry sectors or more general product design aspects, but only a few meetings take place on the subject of DfE. Knowledge of internal DfE resources is also very limited in the company. Contrary to the majority,

they feel very satisfied with their communication and collaboration tools. However, the use of those in terms of DfE still remains relatively very low.

Interviewer: How do you transfer knowledge and DfE knowledge?

DC2: We have a series of forums, engineering forum, design forum, usability forum, but there isn't one for sustainability per se.

About developed DfE knowledge:

IH4: [The employee] built up a lot of background information which was quite useful, could have been quite good but practically didn't communicate it, it is within files in a computer, you know, and I think that would be my, my fault.

There is a level of frustration, mostly from designers in more junior positions regarding communication and collaboration. They are in many cases negative about the ability of their company to learn from previous projects and to transfer knowledge and information.

About communication methods:

IH4: The only time, sadly, that information is spread really through the company is within projects.

Respondent were generally negative about the lack of collaboration and communication within projects. They explained that internally within the design team, information filters down with loss from senior levels and from the client companies. Externally, they also experience difficulties (such as time constraints and retention of information) in gathering information from the supply chain. Loss of information regarding environmental criteria also seems much more affected by the different hierarchical layers of project structure when comparing the views from job types in cases. Overall, it seems that the companies' environmental strategies as well as the products' environmental objectives are not communicated effectively down to the design team.

The problem of communication and collaboration affecting interviewees was not confined to DfE oriented projects but applied to all project types. However, in DfE oriented projects, interviewees express how constraining these problems can become and how they affect the capacity to achieve best performance. In many cases, interviewees reflecting on their practice felt that the lack of information, communication and collaboration often makes it impossible to achieve the desired environmental objectives.

IH1: It's a constant frustration, especially regarding materials. It really is, because I had samples, I've categorised them in a library, I've got people to look at them and they've been quite excited, they've designed them in once. And then, I don't know, it's like it never happened, forgotten.

About client handlers (not) selling environmental alternatives:

IH1: Unless they were specifically asked for an environmental solution they wouldn't do it and they wouldn't be promoting it. However, if you asked them they would say to me that they do promote that!

Internally and in most cases, communication and collaboration on DfE is said to happen through emails and few formal meetings but more usually, it occurs through informal interaction by "bumping into" or around an impromptu "cup of tea".

Driving and Sustaining Implementation

In the majority of cases, there is no process to drive DfE across the product development team. This is usually explained by a lack of time and resource. Isolated employees develop their DfE knowledge mostly through personal interest and in turn try to drive DfE implementation but believe it needs to be led by senior staff to be successful.

About implementing ways to develop DfE knowledge:

Interviewer: Is the push coming from you or from higher management?

DC2: The idea came from me, my manager agrees it would be quite a useful thing to do, but like everything else, it fits into a hierarchy of importance, and he's left it to me to act on it when I can. But we don't have the time luxury to do this at the moment.

DC2: what would be fantastic would be it being driven from the top. Either top within here dedicating budget and time to it, or clients saying they really want it. But it's very difficult because we're a consultancy.

In most cases, sustaining DfE implementation seems as difficult as the implementation itself. Interviewees encountering the problem explained that implementing an environmental alternative on one project provides little benefit for the following one. The knowledge and experience gained on the one project is consequently lost as there are no methods to store or build upon it. This provides DfE with one of its biggest barriers that is the management and therefore the development of this knowledge for future use.

Interviewer: How would you see this continue if you left the company?

DC2: I think it would slow down, then it would stop. [...] It's really much in the realms of knowledge management and of how a company capture its intellectual property that's generated and recycle that in an accessible form.

IH1: You get to see it but you know that it's made an impact that one time; but hasn't made an impact on the design team. I know because it's happened before that, let's say you've got bamboo instead of vinyl, it would be the same price. We've always used vinyl, but we were asked to use bamboo for that project. Next time they do a design for someone else they will revert straight back to vinyl. It's the way they've always done it. It's not embedded because it won't happen again.

Conclusions and Future Research

Although DfE has received a lot of attention from the academic world, especially in the last twenty years, the take up in British industry is still far from being at the same level.

The ongoing research presented in this paper highlights the difficulties that DfE implementation faces within product development teams, such as low reputation and recognition, as well as a lack of cohesive direction. This lack of cohesive direction creates problems of transfer of information, communication and collaboration that hinder the development of sustainable DfE knowledge, the management of which is also critical at a company level in order to sustain and build on success. While communication and collaboration issues are not seen to be unique to DfE, they are significant to the success or failure of DfE product development. The research carried out so far shows that the role of eco-tools has little place in the implementation of DfE. 'Green champions' seem to offer the main driver in this process although their influence remains rather limited.

This paper has highlighted the need for further research to focus on the development of collaboration, knowledge management methods and sustaining knowledge acquisition in DfE. It has also suggested the importance of developing systemic knowledge and knowledge transfer mechanisms at the level of design team, between the team and the wider organisation and throughout the product development chain.